Bell Work
25-April-16

Please compute the " –log(7)" using your calculator?

What are acids and bases?

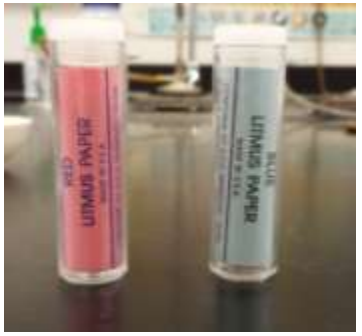
EQ: What bases have you used today and how did they help you?

Agenda:
introduction to Acid Base Chemistry

Objective:

Following the lesson you will be able to distinguish simple acids and bases form each other and name them

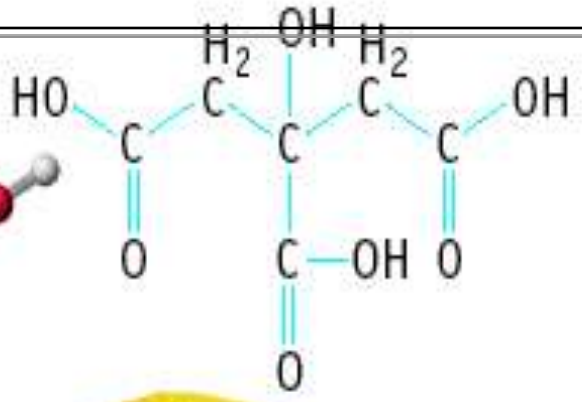
Visual Introduction to Acid Base Chemistry

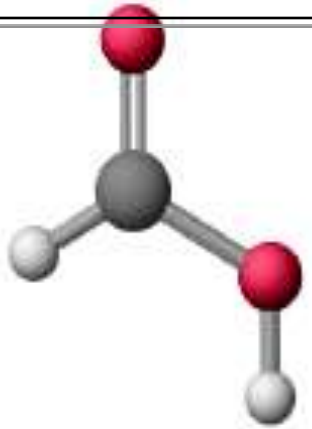


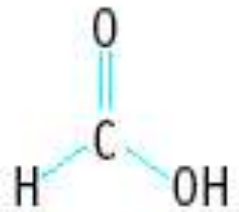
$NaOH\ (aq) + HCl\ (aq) \rightarrow$

$AgNO_3\ (ag) + \rightarrow$

Acid and Bases



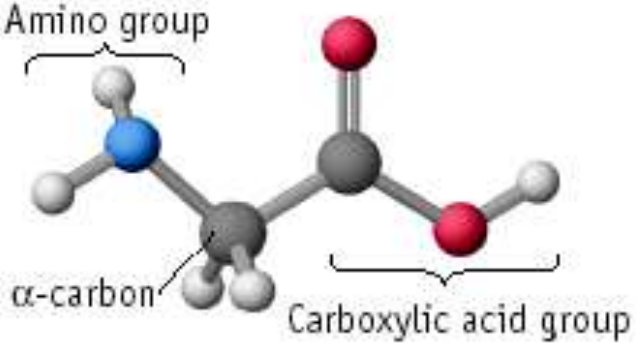




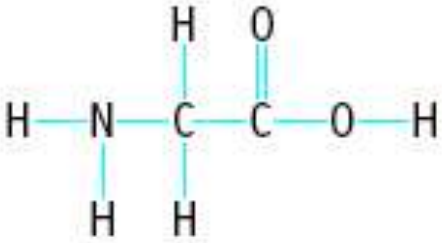
The tartness of lemons and oranges comes from the weak acid citric acid. The acid is found widely in nature and in many consumer products. *(Charles D. Winters)*

The sting of ants is due to the weak acid formic acid, HCO_2H. *(Gallo Images/@ CORBIS)*

Acid and Bases



Aspirin is a weak acid that has been used as an analgesic for over 100 years. *(Charles D. Winters)*

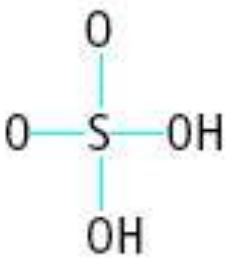


Glycine, $NH_2CH_2CO_2H$

Glycine is representative of the amino acids that are the basis of proteins. The $-CO_2H$ group is the acid portion of the molecule, and the $-NH_2$ group is the basic portion. *(Charles D. Winters)*

Acid and Bases

Caffeine is a well known stimulant and a weak base. *(Charles D. Winters)*



A sea slug excretes the strong acid sulfuric acid in self-defense. *(Sharksong/ M. Kazmers/Dembinski Photo Associates)*

Acids

Multiple definitions:

- Lewis
- Arrhenius
- Bronsted Lowry

Generally it's a chemical compound that produces a hydrogen ion concentration higher then pure water: $[H^+]$ or $[H_3O^+]$

Acids

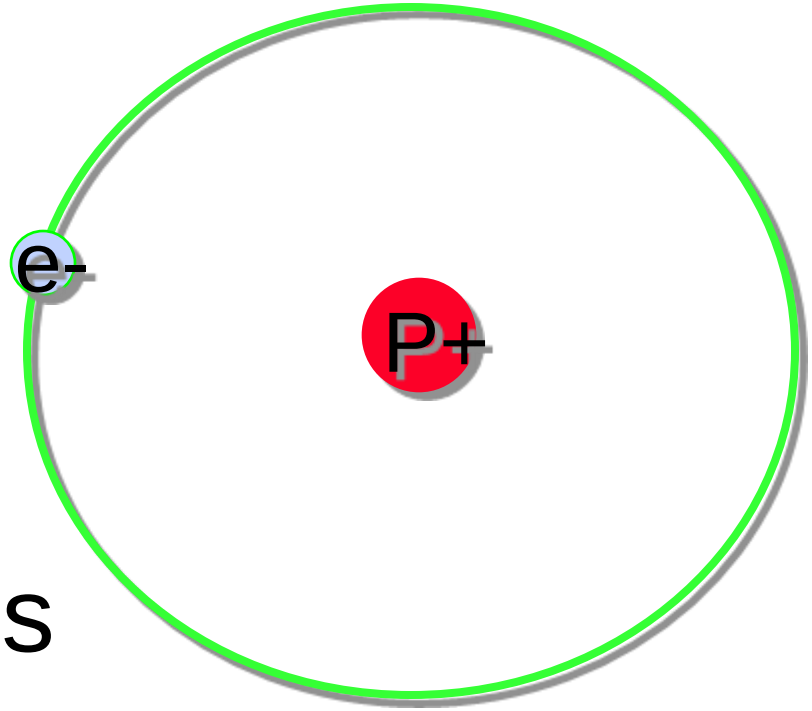
React with carbonates and bicarbonates to produce carbon dioxide gas

Have a sour taste. Vinegar is a solution of acetic acid. Citrus fruits contain citric acid.

Some Properties of Acids

Produce H^+ (as H_3O^+ ions in water):

Call a "proton"



Taste sour

Corrode metals

Acid Nomenclature Review

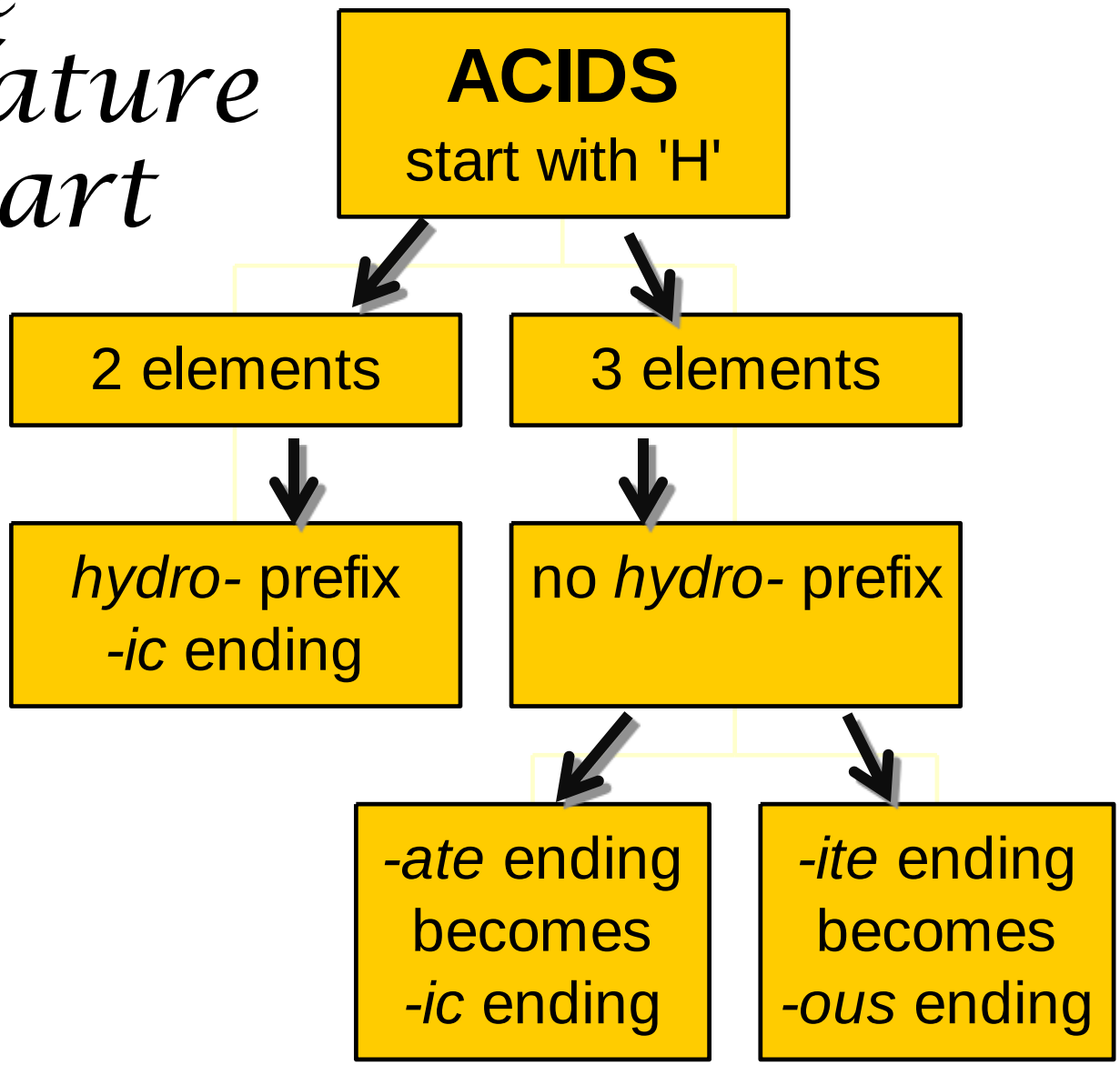
	Anion Ending	Acid Name
Binary →	*-ide*	*hydro-*(stem)*-ic acid*
Ternary	*-ate*	(stem)*-ic acid*
Ternary	*-ite*	(stem)*-ous acid*

Acid Nomenclature Review

An easy way to remember which goes with which…

"In the cafeteria, you ATE something ICky"

Acid Nomenclature Flowchart



Acid Nomenclature Review

$HBr_{(aq)}$ $\Rightarrow$ hydrobromic acid

H_2CO_3 $\Rightarrow$ carbonic acid

H_2SO_3 $\Rightarrow$ sulfurous acid

Strong Acids

Completely dissociates in water.

You will need to remember these three:

HCl

H_2SO_4

HNO_3

Name 'Em!

HF

HCl

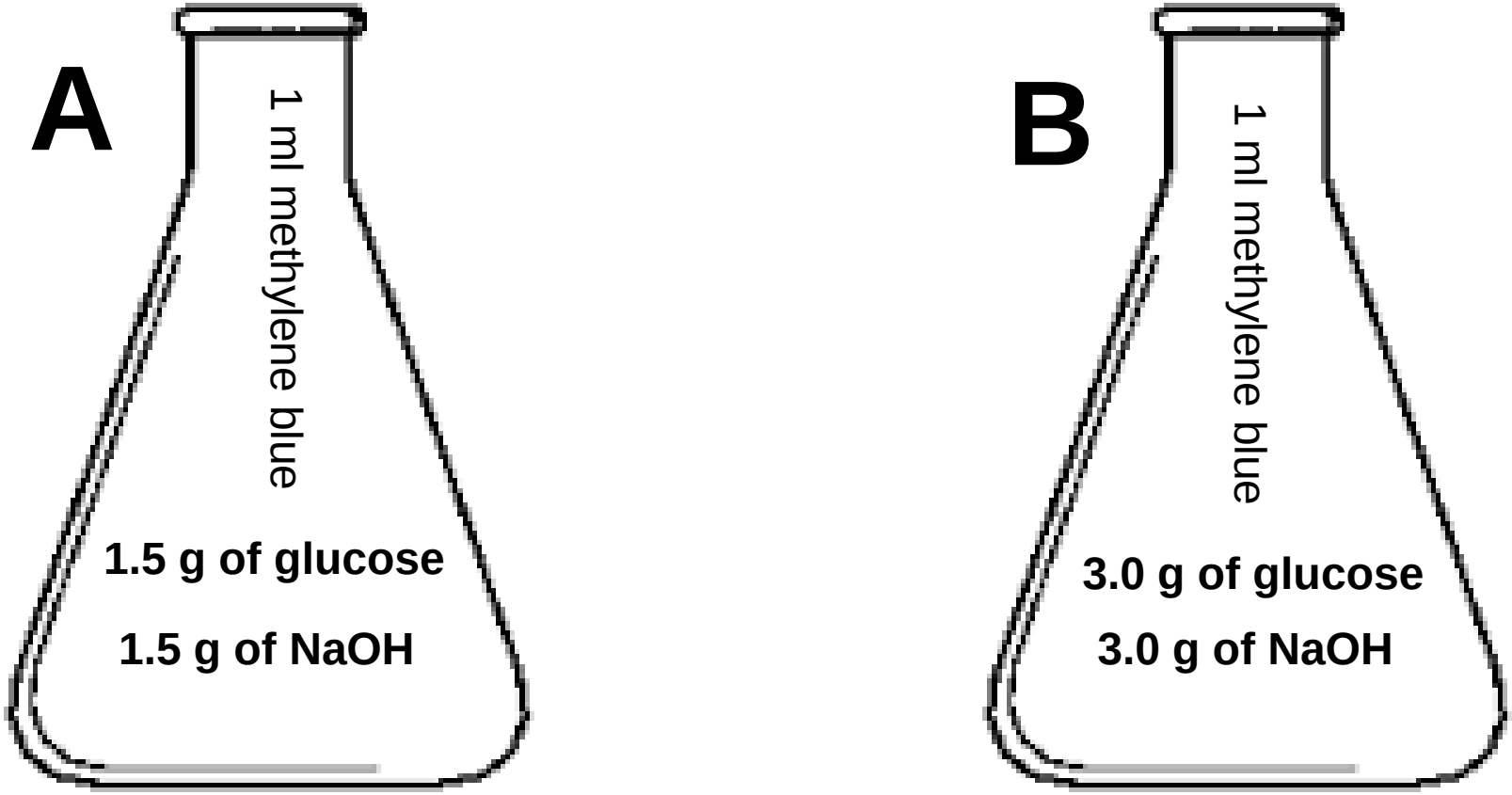
H_2SO_4

HNO_3

HIO_3

Which are strong acids?

Color Change Oxidation



$$2CH_2OH–CHOH–CHOH–CHOH–CHOH–CHO + 1\ O_2 \rightarrow 2CH_2OH–CHOH–CHOH–CHOH–CHOH–COOH$$

Bases

A chemical species that donates hydroxide ions (OH^-) or that accepts protons.

Have a bitter taste.

Feel slippery. Many soaps contain bases.

Some Properties of Bases

Produce OH^- ions in water

Taste bitter, chalky

Are electrolytes

Feel soapy, slippery

Name these Common Bases

NaOH	Drain cleaner
KOH	Liquid soap
$Ba(OH)_2$	Stabilizer for plastics
$Mg(OH)_2$	Milk of magnesia
$Al(OH)_3$	Maalox (antacid)

Naming Bases

Group I metals all form strong bases with hydroxide

Same name as chemical name

Ex. NaOH – Sodium hydroxide

List the rest of them (write their names and chemical formulas)

KNOW THEM

Recall…

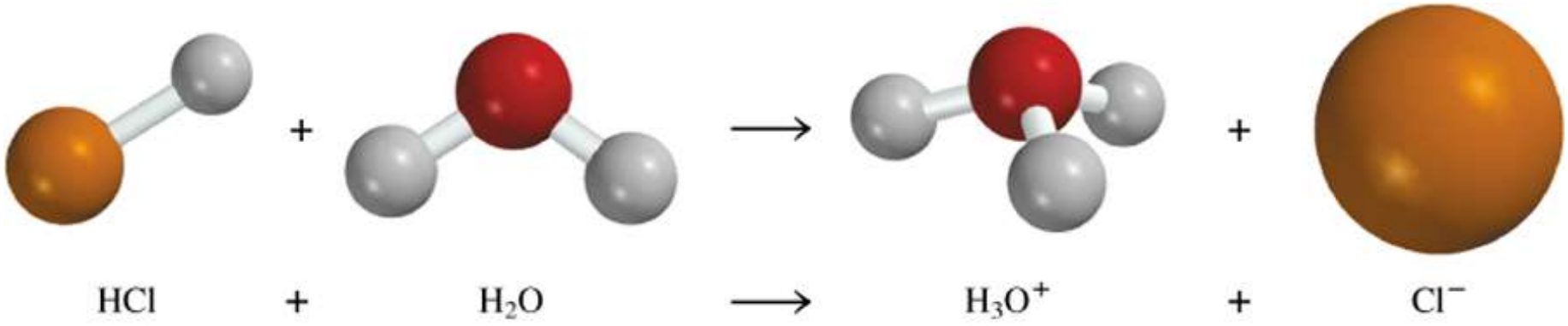
In your own words define:

- What an acid and base are,
- How can you distinguish them,
- How do you name them

Visual Introduction to Acid Base Chemistry

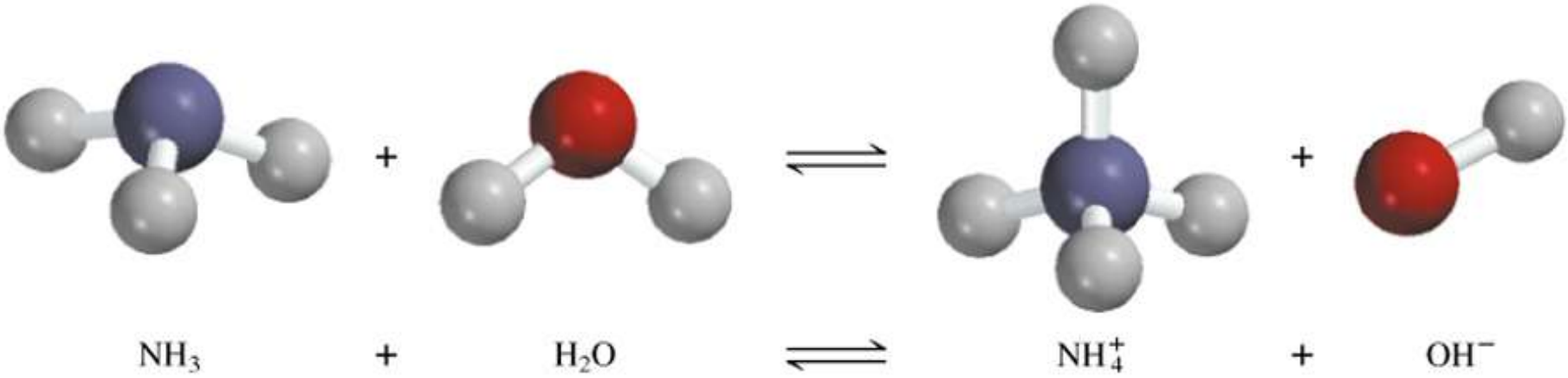
Complete one more section B, C, or D today

Arrhenius acid: "is a substance that produces H^+ (H_3O^+) in water"



$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

Arrhenius base: "is a substance that produces OH^- in water"

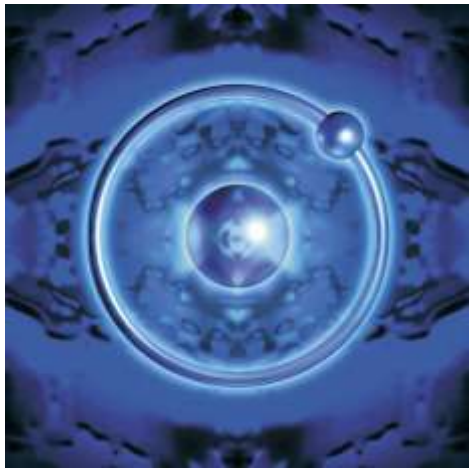


$$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$$

Acid/Base Definitions

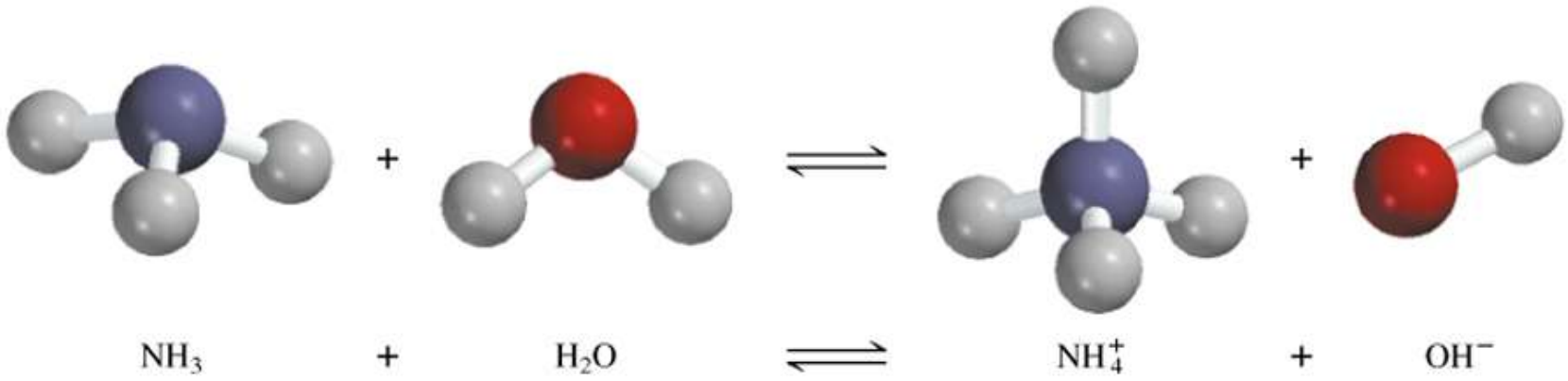
Definition #2 Brønsted – Lowry

- Acids – proton donor
- Bases – proton acceptor
- A “proton” is really just a hydrogen atom that has lost it’s e^-!



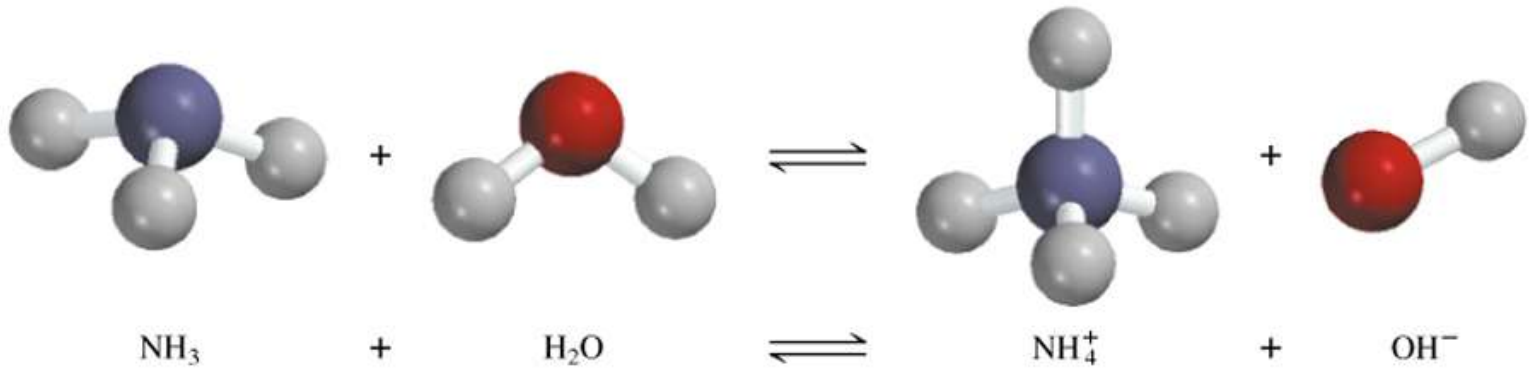
A Brønsted-Lowry acid is a proton donor

A Brønsted-Lowry base is a proton acceptor



NH_3 + H_2O → NH_4^+ + OH^-

base acid conjugate acid conjugate base



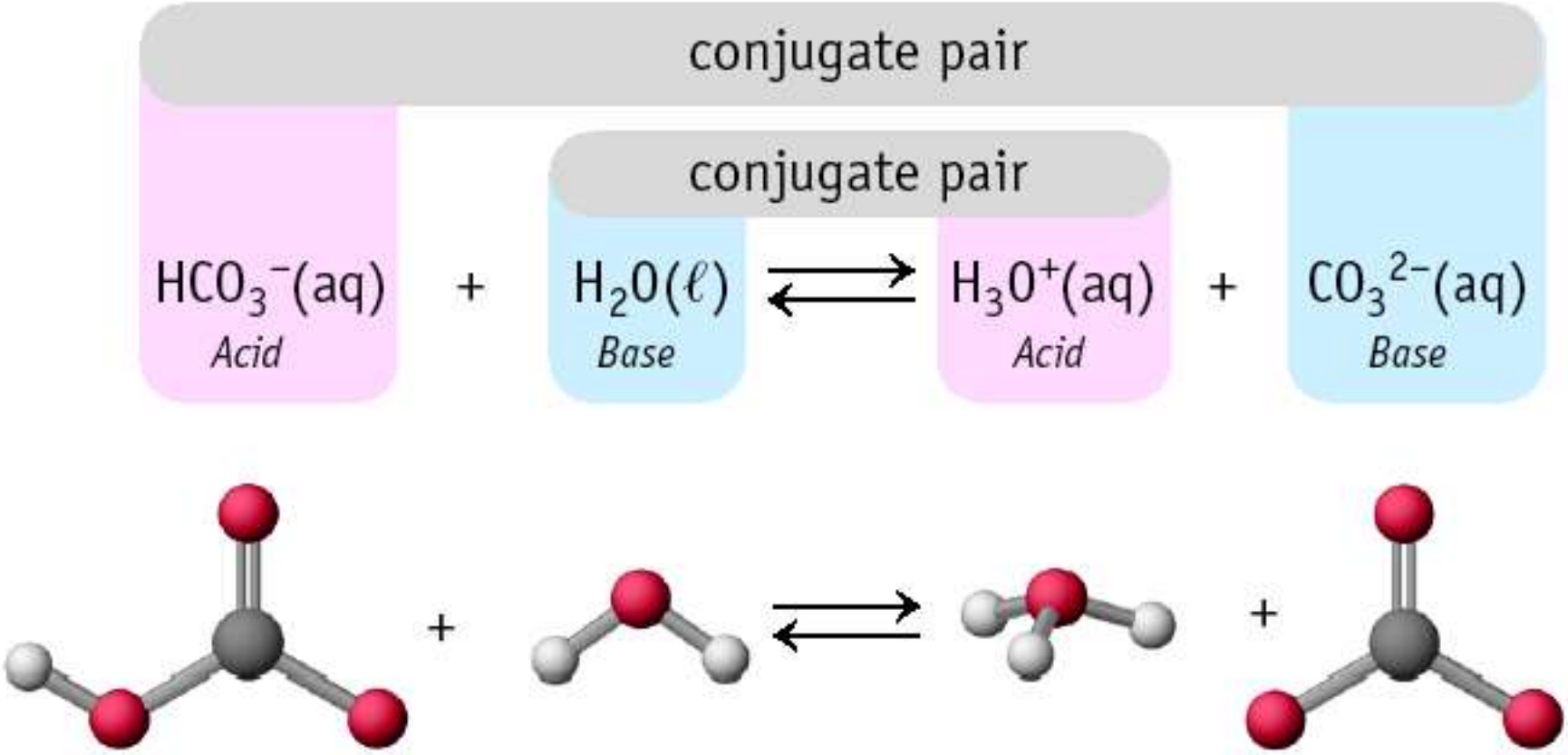
NH_3 + H_2O → NH_4^+ + OH^-

base **acid** **conjugate acid** **conjugate base**

conjugate acid: substance formed when base gains a hydrogen ion

conjugate base: substance formed when an acid loses a hydrogen ion

Conjugate Pairs



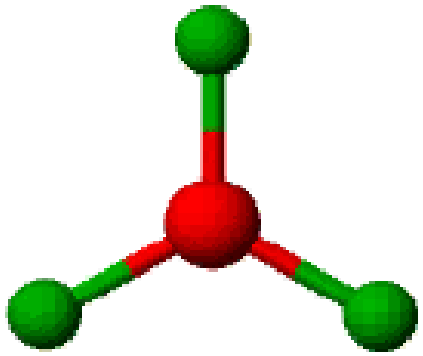
Suggested Practice Homework

Read 574-576, and #1-2

Acids & Base Definitions

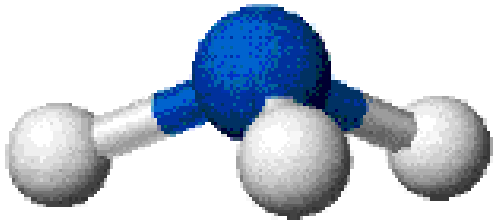
Definition #3: Lewis

Lewis acid - a substance that accepts an electron pair



BF_3, the boron atom is surrounded by only three electron pairs.

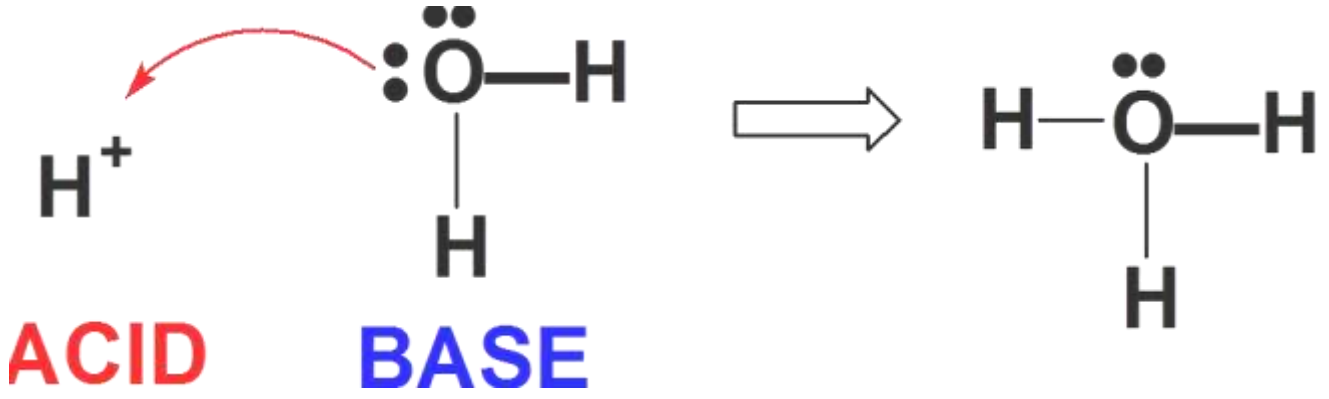
Lewis base - a substance that donates an electron pair



NH_3, the N atom has three bond pairs and one lone pair of electrons.

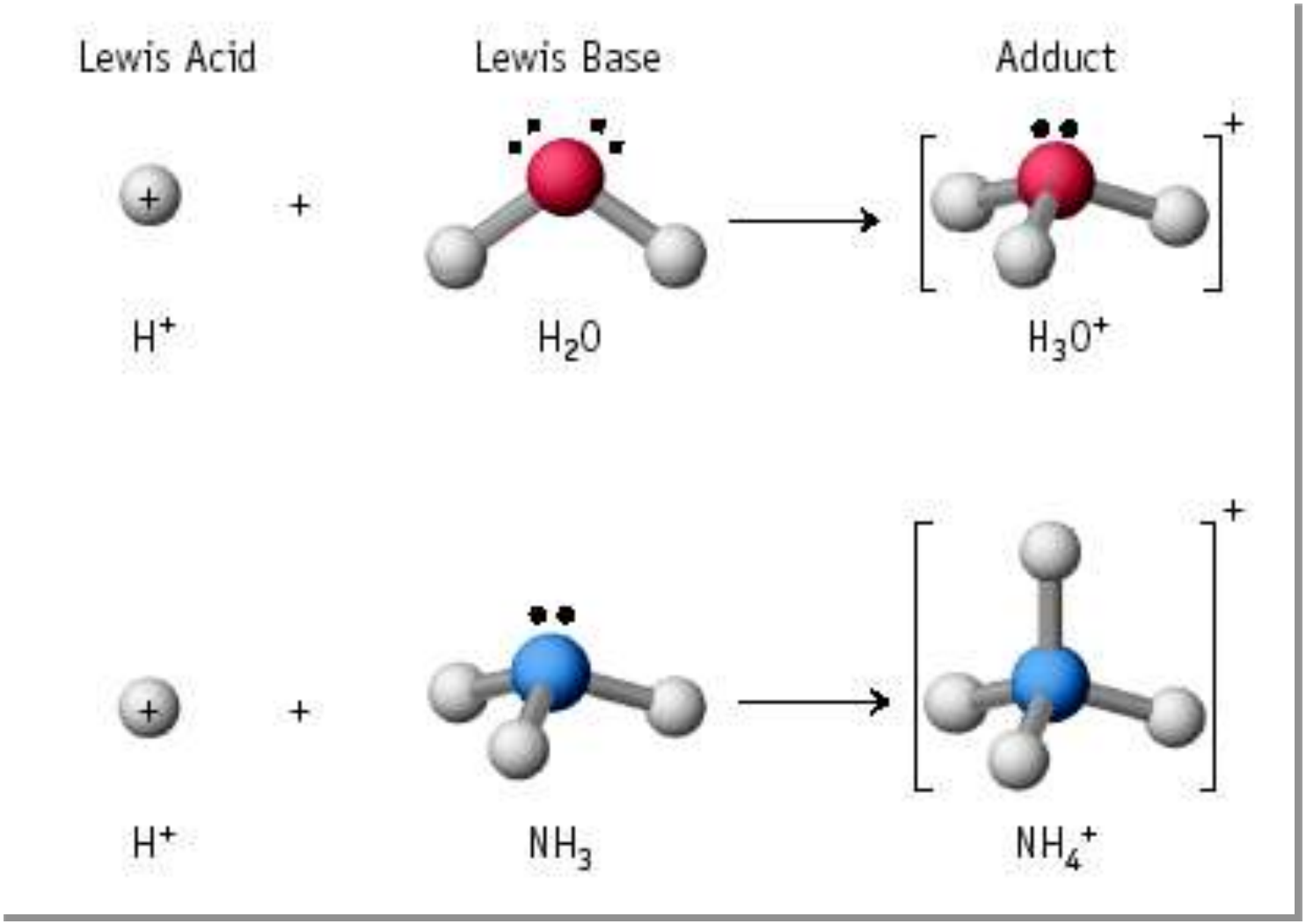
Lewis Acids & Bases

Formation of hydronium ion is also an excellent example.



Electron pair of the new O-H bond originates on the Lewis base.

Lewis Acid/Base Reaction



Learning Check!

Label the acid, base, conjugate acid, and conjugate base in each reaction:

$$HCl + OH^- \rightarrow Cl^- + H_2O$$

$$H_2O + H_2SO_4 \rightarrow HSO_4^- + H_3O^+$$

For most Acid Bases Rxns

The generic equation for most acid base rxn is:

$$HA + BOH \rightarrow BA + H_2O$$

You will get a salt and water out of an acid base rxn!

You try… write out the products:

$HA + BOH \rightarrow BA + H_2O$

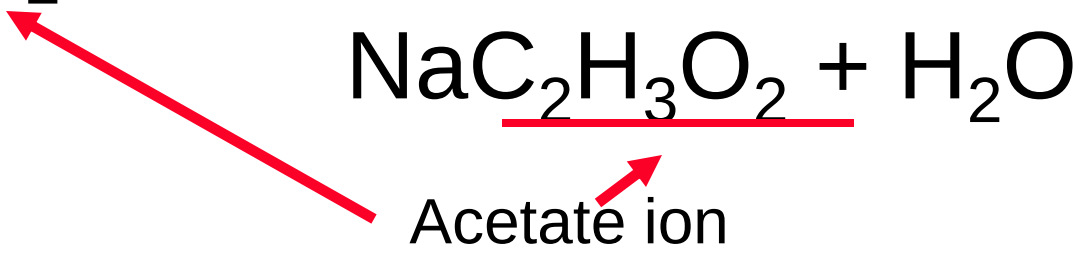
You will get a salt and water out of an acid base rxn!

1) $HCl + NaOH \rightarrow NaCl + H_2O$

2) $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

3) Tricky $HC_2H_3O_2 + NaOH \rightarrow$

$NaC_2H_3O_2 + H_2O$



What volume of a 1.420 *M* NaOH solution is required to titrate 25.00 mL of a 4.50 *M* H_2SO_4 solution?

WRITE THE BALANCED CHEMICAL EQUATION!

$$H_2SO_4 + 2NaOH \rightarrow 2H_2O + Na_2SO_4$$

volume acid $\xrightarrow{M\text{ acid}}$ moles acid $\xrightarrow{\text{Mole Bridge}}$ moles base $\xrightarrow{M\text{ base}}$ volume base

$$25.00\ \text{mL} \times \frac{4.50\ \text{mol}\ H_2SO_4}{1000\ \text{mL soln}} \times \frac{2\ \text{mol NaOH}}{1\ \text{mol}\ H_2SO_4} \times \frac{1000\ \text{ml soln}}{1.420\ \text{mol NaOH}} = 158\ \text{mL}$$

Suggested Practice Homework

Read 580, and #9-12

Bell Work
26-April-16

What are the strong acids you must know?

What is the conjugate base in the reaction below?

$HC_2H_3O_2 + H_2O \rightarrow H_3O^+ + C_2H_3O_2^-$

What do bases taste like?

Agenda

Acid base definitions

pH

Objective:

You will be able to describe the pH scale.

For most Acid Bases Rxns

The generic equation for most acid base rxn is:

$$HA + BOH \rightarrow BA + H_2O$$

You will get a salt and water out of an acid base rxn!

Recap!

Identify the acid, base, and conjugate acid and base in each equation:

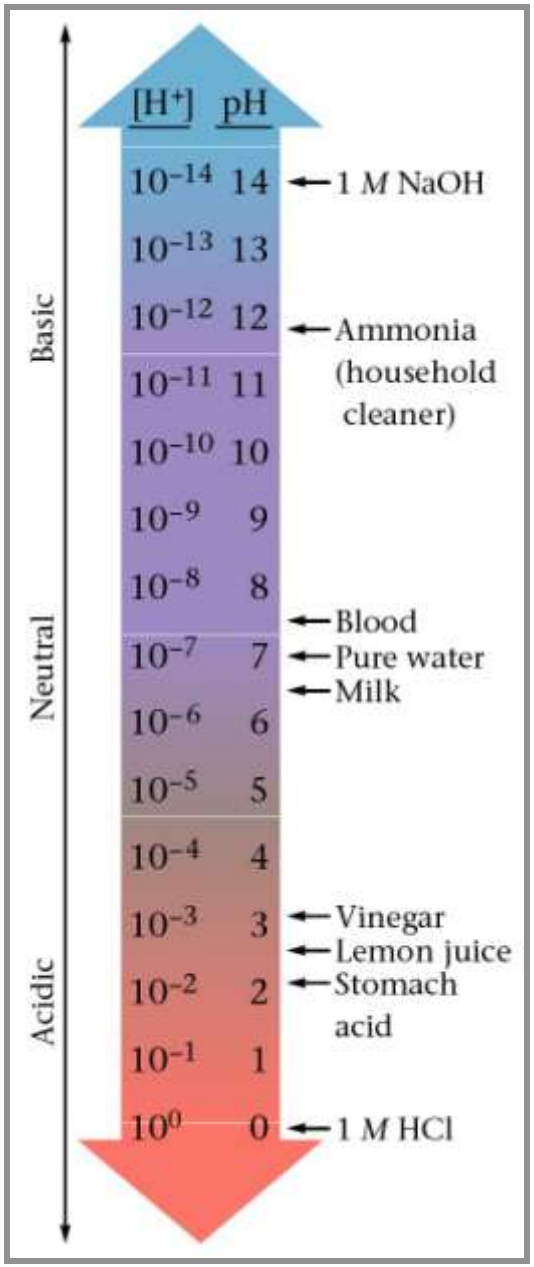
$$H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+$$

pH scale = way of expressing the strength of acids & bases. Instead of using very small #'s, we just use the NEGATIVE power of 10 on the Molarity of the H^+ (or OH^-) ion.

Under 7 = acid

7 = neutral

Over 7 = base



pH of Common Substances

Figure 5.17 **pH values of some common substances.** Here the "bar" is colored red at one end and blue at the other. These are the colors of litmus paper, commonly used in the laboratory to decide if a solution is acidic (litmus is red) or basic (litmus is blue). *(Charles D. Winters)*

Bell Work
27-April-16

A- What is a Brønsted – Lowry base ?

B- what is the $[H^+]$ concentration of a solution with a pH of 8.1?

Agenda

Acid base definitions

pH

pH → $[H^+]$

Objective:

You will start to look at calculating pH and $[H^+]$ and be able to discribe the pH scale.

Calculating the pH

$$pH = - \log [H^+]$$

$$pH = - \log [H_3O^+]$$

(Remember that the [ ] mean Molarity)

Example: If $[H^+] = 1x10^{-10}$

$pH = - \log 1 \times 10^{-10}$

$pH = - (- 10)$

$pH = 10$

For a strong acid [H+] ~ the molarity of the solution

Calculating the pH

pH = - log [H+]

(Remember that the [ ] mean Molarity)

Example: If $[H^+] = 1.8 \times 10^{-5}$

pH = - log 1.8×10^{-5}

pH = - (- 4.74)

pH = 4.74

Try These!

Find the pH of these:

1) A 0.15 M solution of Hydrochloric acid
2) A 3.00 $x10^{-7}$ M solution of Nitric acid
3) A 6.0M solution of Sulfuric acid

pH Cals. Solving for [H+]

If the pH of Coke is 3.12, $[H^+]$ = ???

Because pH = - log $[H^+]$ then

- pH = log $[H^+]$

Take antilog (10^x) of both sides and get

$10^{-pH} = [H^+]$

$[H^+] = 10^{-3.12} = 7.6 \times 10^{-4}$ M

*** to find antilog on your calculator, look for "Shift" or "2nd function" and then the "log" button

Homework

Finish pH Acid Base Practice up to Titrations

Practice

What is the pH of a solution with a proton concentration of 0.032 M?

What is the proton concentration in a solution with pH of 9.24?

pH Cals. Solving for H+

A solution has a pH of 8.5. What is the Molarity of hydrogen ions in the solution?

$pH = - \log [H^+]$

$8.5 = - \log [H^+]$

$-8.5 = \log [H^+]$

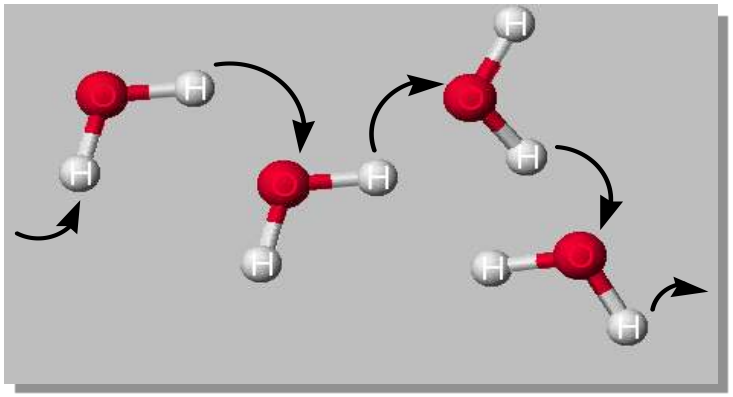
Antilog -8.5 = antilog $(\log [H^+])$

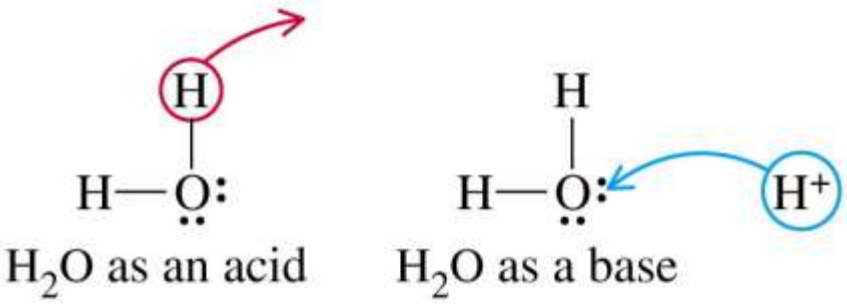
$10^{-8.5} = [H^+] \rightarrow$ **3.16×10^{-9} M**

More about Water

H_2O can act as both an ACID & a BASE.

In pure water there can be
AUTOIONIZATION





H_2O as an acid H_2O as a base

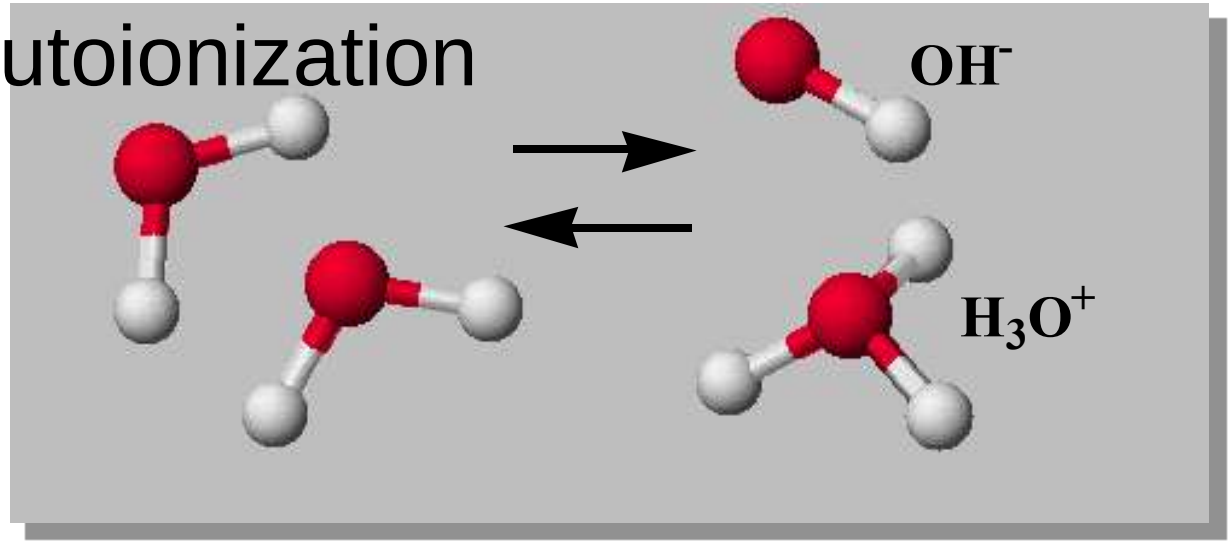
Equilibrium constant for water = K_w

$K_w = [H_3O^+]\,[OH^-] =$

$K_w = [H^+]\,[OH^-] =$

1.00×10^{-14} at 25 °C

More about Water



$K_w = [H_3O^+]\,[OH^-] = 1.00 \times 10^{-14}$ at 25 ^oC

In a neutral solution $[H_3O^+] = [OH^-]$

so $K_w = [H_3O^+]^2 = [OH^-]^2$

and so $[H_3O^+] = [OH^-] = 1.00 \times 10^{-7}$ M

pOH

Since acids & bases are opposites, pH and pOH are opposites!

pOH does not really exist, but it is useful for changing bases to pH.

$$\underline{pOH = - \log [OH^-]}$$

Since pH and pOH are on opposite ends of scale,

$$pH + pOH = 14$$

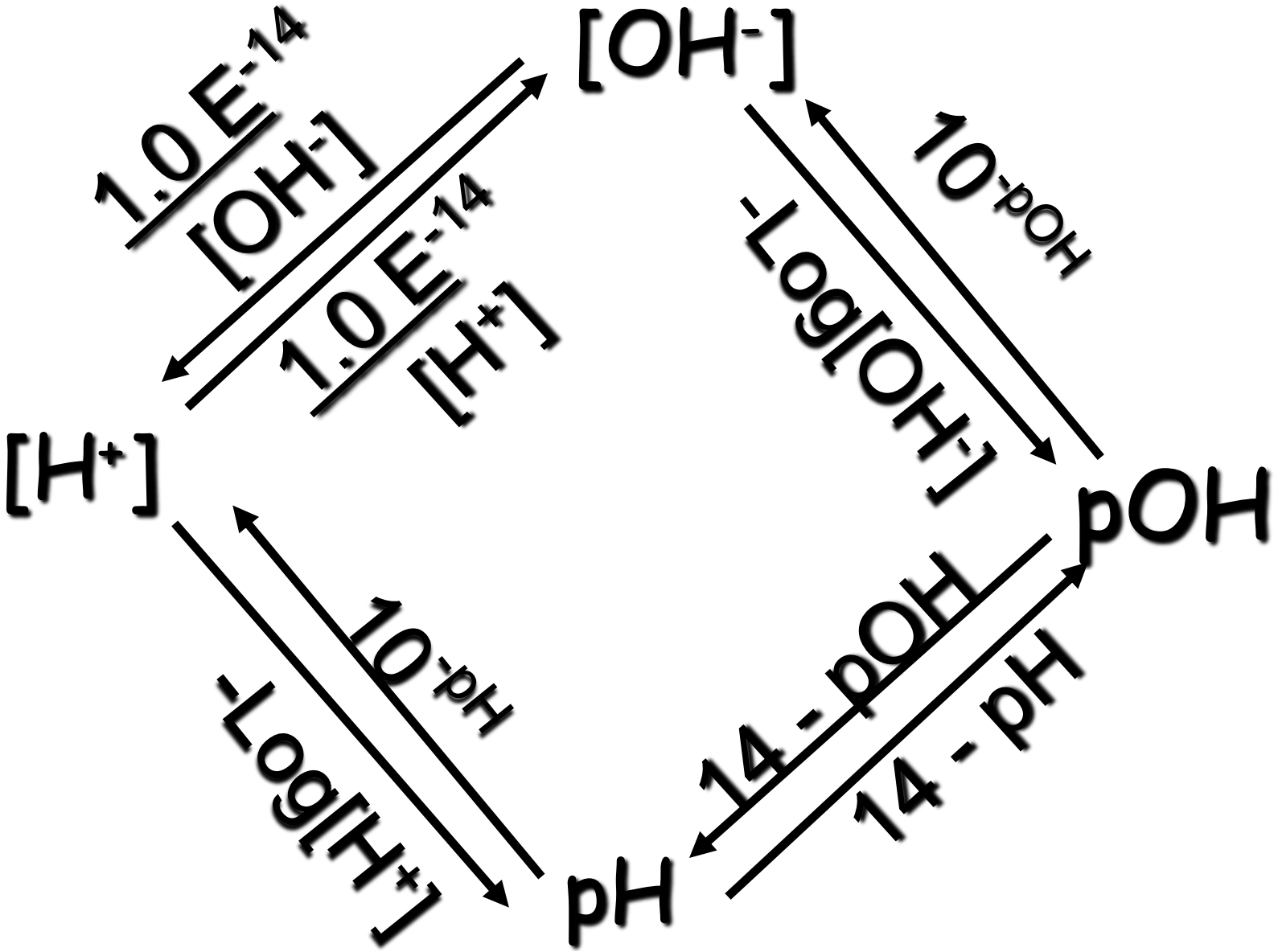
$\mathcal{K}_w$

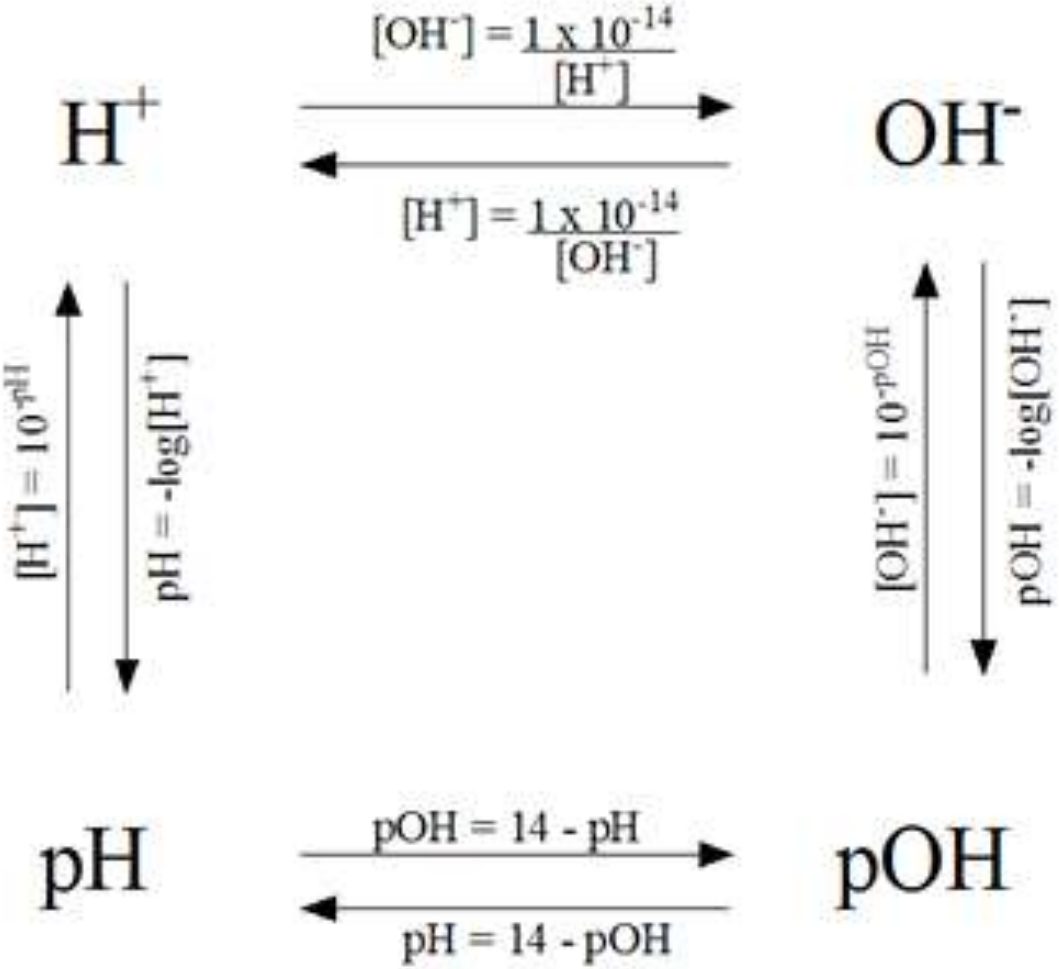
Water dissociation constant; K_w.

$K_w = 1.0 \times 10^{-14}$

$K_w = [H^+][OH^-]$

$1.0 \times 10^{-14} = [H^+][OH^-]$


[OH-]
[H+]
pOH
pH
1.0 E-14 / [OH-]
1.0 E-14 / [H+]
10-pOH
-Log[OH-]
10-pH
-Log[H+]
14 - pOH
14 - pH

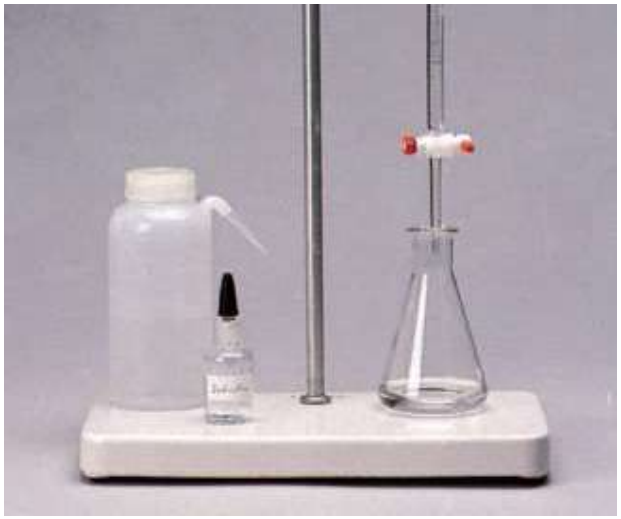

H+
OH-
pH
pOH
[OH-] = 1 x 10-14 / [H+]
[H+] = 1 x 10-14 / [OH-]
[H+] = 10-pH
pH = -log[H+]
[OH-] = 10-pOH
pOH = -log[OH-]
pOH = 14 - pH
pH = 14 - pOH

Titrations

In a *titration* a solution of accurately known concentration is added gradually added to another solution of unknown concentration until the chemical reaction between the two solutions is complete.

Equivalence point the point at which the reaction is complete

Indicator – substance that changes color at (or near) the equivalence point



Slowly add base to unknown acid UNTIL

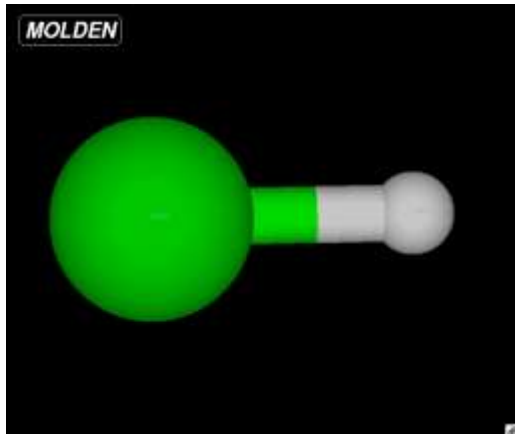
the indicator changes color

Acid Base Rxn Titration

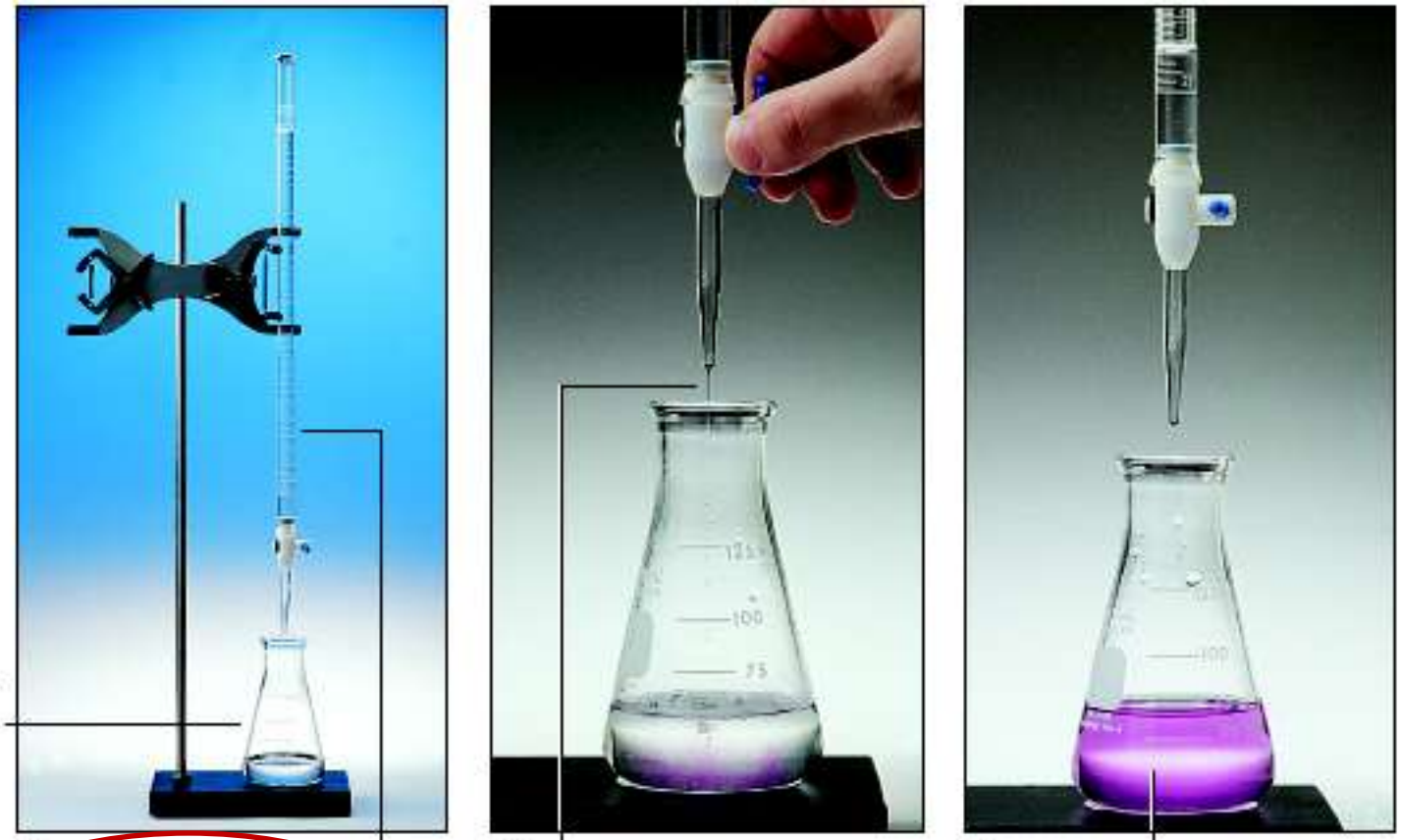
$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

acid base

Carry out this reaction using a TITRATION.



Setup for titrating an acid w/ a base



Bell Work
29-April-2016

Please complete the "Intro to Titration Lab", data table on a blank sheet of paper

	Trial 1	Trial 2	Trial 3	Trial 4
Molarity of NaOH				
Initial Burret reading (ml)				
Final Buret reading (ml)				
Amount of NaOH despinsed (ml)				
Vol. of Unknown acid used (ml)				
Molarity of unknown acid				

When ammonia reacts with water an ammonium ion and hydroxide is produced.

-Write a balanced equations.

-What type of base is ammonia if it is producing hydroxide?

Intro to Titrations

1. Add solution from the buret (base).
2. Reagent (base) reacts with compound (acid) in solution in the flask.
3. Indicator shows when exact stoichiometric reaction has occurred. [Acid] = [Base])

This is called NEUTRALIZATION.

Acid Base Titration Calculations

Recall our dilution formula

$$M_1V_1 = M_2V_2$$

M = Molarity (mol/L)

V = Volume (L)

Think of it like this:

$$M_{acid}V_{acid} = M_{base}V_{base}$$

Lab example: Neutralization of NaOH by HCl

35.62 mL of NaOH is neutralized with 25.2 mL of 0.0998 M HCl by titration to an equivalence point. What is the concentration of the NaOH?

Problem

What volume of 0.1M HNO_3 is need to completely neutralize 0.050L of 0.2 M NaOH?

What are we looking for?

What do we know

Acid Base Titration

$[H_3O^+]$, $[OH^-]$ and pH

What is the pH of the 0.0010 M NaOH solution?

[OH-] = 0.0010 (or 1.0×10^{-3} M)

pOH = - log (0.0010)

pOH = 3

pH = 14 – 3 = 11

OR

$K_w = [H^+]\,[OH^-]$

$[H^+] = 1.0 \times 10^{-11}$ M

pH = - log (1.0×10^{-11}) = 11.00

A man went into the doctor for testing, the tests revealed that he had a $[OH^-]$ of 1.28×10^{-12}. What is the pH of his urine?

You Try ☺

The pH of rainwater collected in a certain region of the northeastern United States on a particular day was 4.82. What is the H^+ ion concentration of the rainwater?

You Try ☺

The OH^- ion concentration of a blood sample is 2.5×10^{-7} M. What is the pH of the blood?

Calculating [H+], pH, [OH-], and pOH

Problem 1: A chemist dilutes concentrated hydrochloric acid to make two solutions:

(a) 3.0 *M*

(b) 0.0024 *M*.

Calculate the $[H^+]$, pH, $[OH^-]$, and pOH of the two solutions at 25°C.

Calculating [H+], pH, [OH-], and pOH

Problem 2: What is the $[H^+]$, $[OH^-]$, and pOH of a solution with pH = 3.67? Is this an acid, base, or neutral?

Problem 3: What is molarity of a solution made from 4.5g of NaOH dissolved to a volume 450ml? If you furture diluted it to 800ml what would its new molarity be?

Objective

Are you up to speed?

pH, [H+], etc. calculation practice

Calculating $[H^+]$, pH, $[OH^-]$, and pOH

Problem 4:

What is the $[H^+]$, $[OH^-]$, and pOH of a solution with pH = 8.05? Is this an acid, base, or neutral?

Problem 5:

What is the $[H^+]$, $[OH^-]$, and pH of a solution with pOH = 12.05? Is this an acid, base, or neutral?

Calculating $[H^+]$, pH, $[OH^-]$, and pOH

Problem 6:

If 20ml of a 19.0M solution of NaOH is added to 2 480ml of water, what is the new molarity?

What is the *molality*?

What is the pH?

Homework
29-April-2016

Finish Acid Base Practice

#20-23; Titration

Bell Work
2-May-2016

When 15mL of Nitric Acid is triturated with 21.5mL of 0.5M Potassium Hydroxide to neutralization:

1. Write a balanced equation *and* net ionic equation
2. What is the concentration of the nitric acid
3. What is the pH of the nitric acid?

$$M_{acid}V_{acid} = M_{base}V_{base}$$

The Weak Acid / Base Rxn

Recall a balanced equation.

What is on the left side?

The right side?

When you compare the concentration (molarity, [mol/L]) of all reactants and to all products you get something called and <u>equilibrium expression</u>.

Where “K” is the equilibrium constant for that rxn

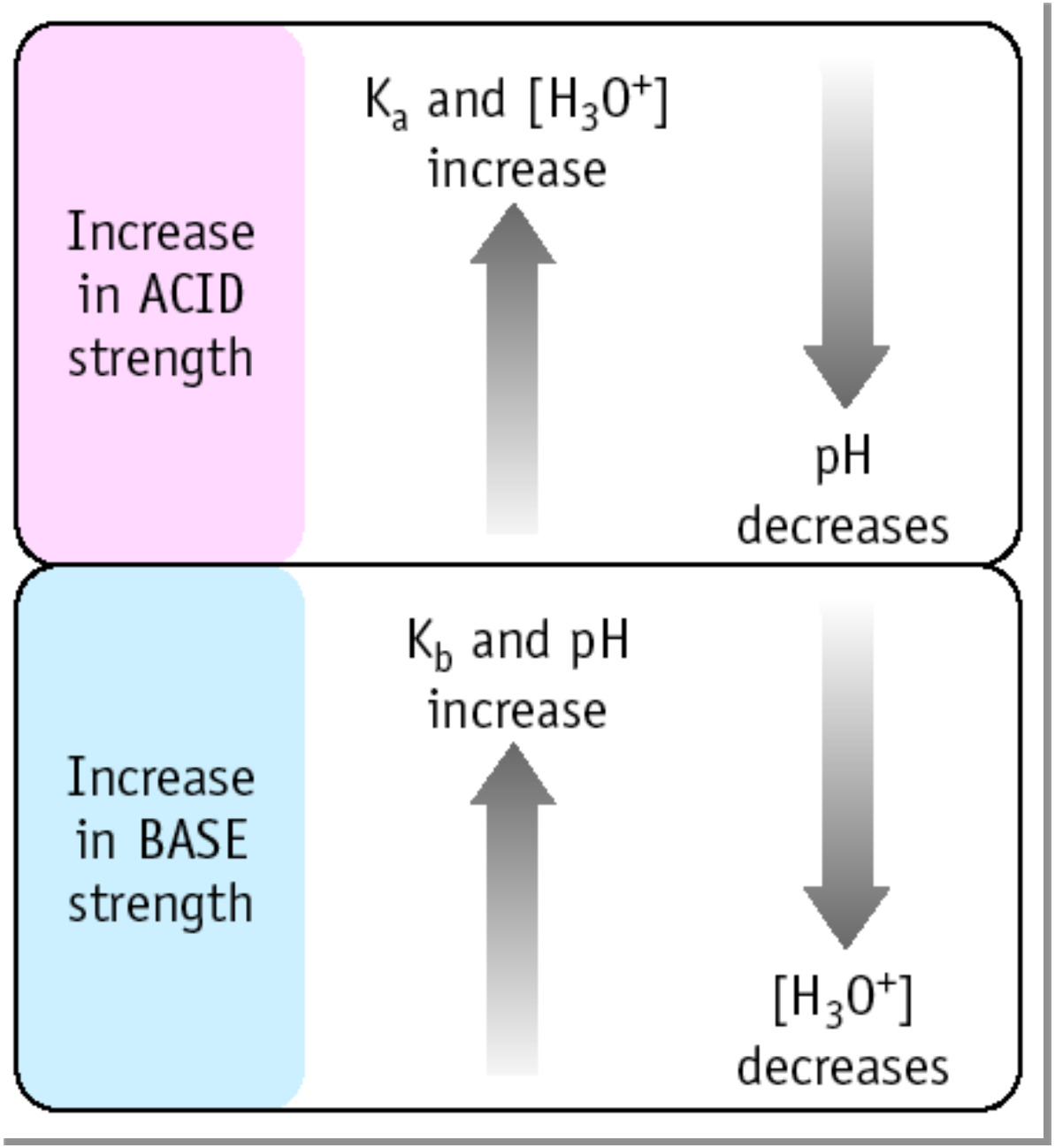
Equilibrium constants for Weak Acids

$$HA(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + A^-(aq)$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

Weak acid has $K_a < 1$

Leads to small $[H_3O^+]$ and a pH of 2 - 7



Relation of K_a, K_b, $[H_3O^+]$ and pH

I.C.E. Table Method

I = Initial concentration, M

C = Change concentration, M

E = Equilibrium concentration, M

RXN	HA→	H^+	A^-
I	[HA]	0	0
C	-x	+x	+x
E	[HA]-x	x	x

I.C.E. Table Method

Step 1: Write balanced equation

Step 2: Write equilibrium (K_a) expression

Step 3: Construct ICE table and fill in

Step 4: Solve for unknown concentrations using equilibrium values, use $[H_3O^+]$ or $[H^+]$ to find pH if asked

Practice

If the K_a of an acid, "A," is 1.5×10^{-2}, what can you tell about its pH compared acid "B" who's K_a is 6.2×10^{-4}?

Equilibria involving weak acids

You have 1.00 M $HC_2H_3O_2$ Calc. the equilibrium concs. of $HC_2H_3O_2$, H^+, $C_2H_3O_2^-$, and the pH. ($K_a = 1.8x10^{-5}$)

Step 1. Write balanced equation.

$$HC_2H_3O_2 + H_2O \leftrightarrow H_3O^+ + C_2H_3O_2^-$$

or

$$HC_2H_3O_2 \leftrightarrow H^+ + C_2H_3O_2^-$$

Equilibria involving weak acids

You have 1.00 M $HC_2H_3O_2$ Calc. the equilibrium concs. of $HC_2H_3O_2$, H^+, $C_2H_3O_2^-$, and the pH. ($K_a = 1.8 \times 10^{-5}$)

Step 2. Write equilibrium (K_a) expression.

$$K_a = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

Equilibria involving weak acids

You have 1.00 M $HC_2H_3O_2$ Calc. the equilibrium concs. of $HC_2H_3O_2$, H^+, $C_2H_3O_2^-$, and the pH. ($K_a = 1.8x10^{-5}$)

Step 3. Construct ICE table and fill in.

	$[HC_2H_3O_2]$	$[H^+]$	$[C_2H_3O_2^-]$
Initial	1.00	0	0
Change	-x	+x	+x
Equilib.	1.00-x	x	x

Equilibria involving weak acids

You have 1.00 M $HC_2H_3O_2$ Calc. the equilibrium concs. of $HC_2H_3O_2$, H^+, $C_2H_3O_2^-$, and the pH. ($K_a = 1.8x10^{-5}$)

Step 4. Solve for unknown concentrations using equilibrium values, use $[H_3O^+]$ or $[H^+]$ to find pH if asked

$$K_a = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]} = 1.8x10^{-5} = \frac{[x^2]}{[1.0-x]}$$

This is a quadratic. Solve using quadratic formula.

or you can make an approximation if x is very small!

(Rule of thumb: 10^{-4} or smaller is ok)

Equilibria involving weak acids

You have 1.00 M $HC_2H_3O_2$ Calc. the equilibrium concs. of $HC_2H_3O_2$, H^+, $C_2H_3O_2^-$, and the pH. ($K_a = 1.8 \times 10^{-5}$)

Step 4. Solve K_a expression

$$K_a = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]} \qquad K_a = \frac{[x][x]}{[1.0-x]}$$

First assume x is very small because K_a is so small.

$$\mathbf{K_a = 1.8 \times 10^{-5} = \frac{x^2}{1.00}}$$

Equilibria involving weak acids

You have 1.00 M $HC_2H_3O_2$ Calc. the equilibrium concs. of $HC_2H_3O_2$, H^+, $C_2H_3O_2^-$, and the pH. ($K_a = 1.8 \times 10^{-5}$)

Step 4. Solve K_a approximate expression

$$K_a = 1.8 \times 10^{-5} = \frac{x^2}{1.00}$$

$$x = [H^+] = [C_2H_3O_2^-] = 4.2 \times 10^{-3}\ M$$

$$pH = -\log[H^+] = -\log(4.2 \times 10^{-3})$$

$$= 2.37$$

Practice

What is the pH of a 0.020 M citric acid , $H_3C_6H_8O_7$, solution? $K_a = 7.5 \times 10^{-4}$

pH =? We need $[H^+]$ 1st $[H_3C_6H_8O_7] = 0.020M$

Weak acid, $K_a = 7.5 \times 10^{-4}$

Rxn	**$H_3C_6H_8O_7$**	**H^+**	**$H_2C_6H_8O_7^-$**
I			
C			
E			

$K_a =$ _____

So since x = [H+] then pH must be?

Bell Work 3-May-2016

A. What is the major difference between a strong acid and a weak acid?

B. What is the concentration of NaOH in a burret if it took 18.1mL to neutralize 0.620g of K.H.P. (M.M. 204g/mol, $C_8H_5KO_4$) ?

(Hint KHP : NaOH is $1H^+$: $1OH^-$)

Agenda

Weak Acids Continued

Standardization of NaOH and pH Apple Juice Lab

Objective:

You will know how to find the H+ of a weal acid give the equilibrium constant and be able to explain what a standardization titration is.

Weak Acid Practice

If a 3.0M weak acid HF is used to etch glass, we need to find the concentration of $[H^+]$ ions in the solution.

1. Write the balance ionization/ dissociation of HF.

2. Write the K_a expression for HF ionization!

From Bellwork

If a 3.0M weak acid HF is used to etch glass, we need to find the concentration of $[H^+]$ ions in the solution. Given the K_a of HF as 6.3×10^{-4}.

From Bellwork

If a 3.0M weak acid HF is used to etch glass, we need to find the concentration of $[H^+]$ ions in the solution. Given the K_a of HF as 6.3×10^{-4}.

Now use the quadratic equation ☺

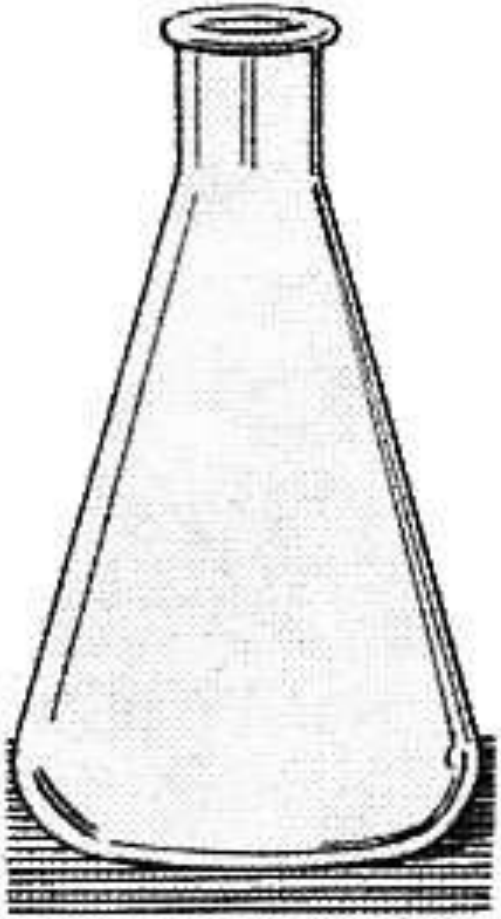
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Practice

What is the pH of a 0.020 M Sulfurous Acid, H_2SO_3, solution? $K_a = 1.4 \times 10^{-2}$

Rxn	H_2SO_3	H^+	HSO_3^-
I			
C			
E			

K_a is $>1.0 \times 10^{-2}$ so we need to use quadratic to solve for "x"



Standardization of NaOH Solution by Colorimetric Titration

Corrections

Page 2

"8: How much KHP would react completely with 15mL of ~~0.1M~~ 0.05M NaOH?"

"Materials: ~~0.1M~~ 0.05M sodium hydroxide (NaOH)"

Page 3

"5. Add ~ 50mL of ~~~0.1M~~ ~0.05M NaOH to your buret"

Part II 1. Refill your buret to between the 0 and 5mL mark with the ~~~0.1M~~ ~0.05M NaOH

Bell Work
4-May-2016

Before you sit down please get safety goggles.

The dissociation constant for a weak base is K_b. Given that $K_w = K_a \times K_b$ and that $K_w = 1.0 \times 10^{-14}$, what is the value of K_b? For acetate ion if the K_a of acetic acid is 1.8×10^{-5}?

Agenda

Questions about K_a Expression from yesterday, K_b ?

You will standardize a NaOH sample

Objective:

You will know how to find the equilibrium constant of a weak base

Standardization Titration Lab

Two part lab:
Part I: Titration 1 find moalrity of NaOH
We will use a salt, KHP ($KHC_8H_4O_4$) to find the exact molarity of NaOH.
Once we know the molarity of the NaOH, we will…

Part II: Find molarity of unknown Apple Juice,
Again perform titrations to find the exact molarity of your unknown Apple Juice

Standardization Titration Lab

Two part lab:
Part I: Titration 1 find moalrity of NaOH

How many grams of KHP are you going to use?

What glassware will you use to make your KHP solution?

Standardization of NaOH and pH of Apple Juice

Equilibrium constants for Weak Base

$$B(aq) + H_2O(\ell) \rightleftharpoons BH^+(aq) + OH^-(aq)$$

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

Weak base has $K_b < 1$

Leads to small $[OH^-]$ & a pH of 12 - 7

Equilibria Involving A Weak Base

You have 0.010 M NH_3. Calc. the pH.

$K_b = 1.8\ E^{-5}$

Step 1. Write a balanced equation

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

Equilibria Involving A Weak Base

You have 0.010 M NH_3. Calc. the pH.

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

$K_b = 1.8\ E^{-5}$

Step 2. Define K_b expression

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

Equilibria Involving A Weak Base

You have 0.010 M NH_3. Calc. the pH.

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

$K_b = 1.8\ E^{-5}$

Step 3. Define equilib. concs. in table

	$[NH_3]$	$[NH_4^+]$	$[OH^-]$
initial	0.010	0	0
change	-x	+x	+x
Equilib.	0.010-x	x	x

Equilibria Involving A Weak Base

You have 0.010 M NH_3. Calc. the pH.

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

$K_b = 1.8 \times 10^{-5}$

Step 4. Solve the equilibrium expression

$$K_b = 1.8 \times 10^{-5} = \frac{[NH_4^+][OH^-]}{[NH_3]} = \frac{x^2}{0.010 - x}$$

Assume x is small, so

$x = [OH^-] = [NH_4^+] = 4.2 \times 10^{-4}$ M

and $[NH_3] = 0.010 - 4.2 \times 10^{-4} \approx 0.010$ M

The approximation is valid !

Equilibria Involving A Weak Base

You have 0.010 M NH_3. Calc. the pH.

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

$K_b = 1.8 \times 10^{-5}$

Step 4. Calculate pH

$[OH^-] = 4.2 \times 10^{-4}$ M

so pOH = - log $[OH^-]$ = 3.37

Because pH + pOH = 14,

pH = 10.63

Now some practice ☺

The 1.0M weak base ethylamine ($C_2H_5NH_2$) has a K_b of 6.4×10^{-4} what is the pH of the solution (find $[OH^-]$ then convert to pH)

A 0.40 M solution of the lactate ion ($C_3H_5O_3^-$) (a weak base), has a pH of 8.728. Calculate the K_b of the lactate ion ($C_3H_5O_3^-$)

Now a hard one ☺

What is the K_a of the weak acid phenylacetic acid, $C_6H_5CH_2COOH$, if 2.1 % of the acid dissociates in a 0.12 M solution ?

Bell Work
9-Ma7-2016

What is the concentration of 15ml of HCl that was neutralized using 0.75M NaOH at a volume of 12.5ml? What is the pH of the HCl?

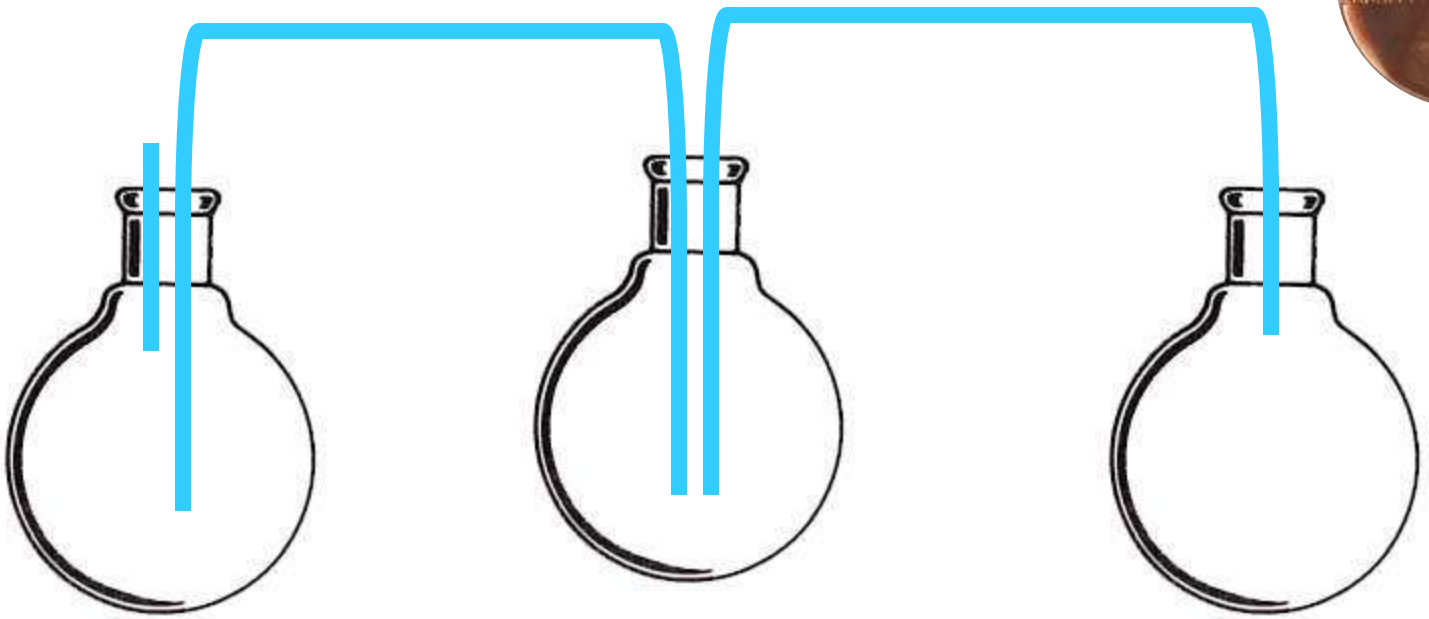
$$M_{acid}V_{acid} = M_{base}V_{base}$$

Turn in

Standardization Lab

Weak Acid Practice

Penny Fountain



70ml of 0.1M NaOH

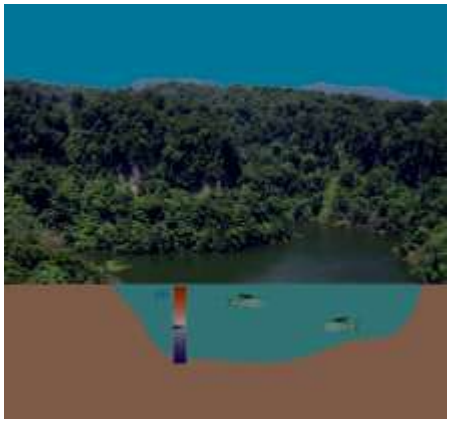
150ml of 0.1M HNO_3 + Phenophtalien

10ml of 16M HNO_3

What is the acid base reaction here?

Penny Fountain
Redox Reaction

Nitric oxide (NO) is oxidized by atmospheric molecules, such as ozone (O_3) or hydrogen dioxide (HO_2), to form nitrogen dioxide (NO_2). Nitrogen dioxide (NO_2) reacts with OH in the atmosphere to form nitric acid (HNO_3).



Penny Fountain
Redox Reaction

$Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO_2$

Balance as:

$Cu + NO_3^- \rightarrow Cu^{2+} + NO_2$

Penny Fountain Heat exchange

$$Cu(s) + HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + NO_2(g)$$

If the reaction took place in a sealed contianer submerged in in 500mL of water at 20˚C, what quantitiy of heat was exchanged if the water hit a maximum temperature of 35˚C?

Penny Fountain
Gas Law Rxn

$Cu(s) + HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + NO_2(g)$

Given the balanced equation above, what volume of gas is produced at 23°C and 0.9atm, if a ____g penney is used?